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(54) Abstract Title
Image encoding

(57) In MPEG coding, a determination is made of the maximum practical visual quality ascertainable in the displayed image. It is then ensured that the degree of compression is not reduced beyond a level which would produce a visual quality in excess of the maximum practical visual quality. Bit capacity released in this way can be used for opportunistic data insertion.

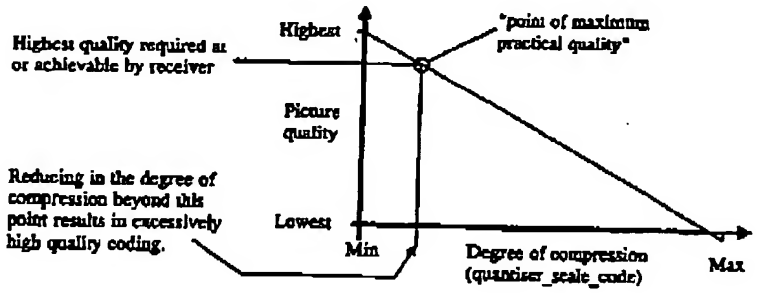

Figure 1

GB 2 341 745 A

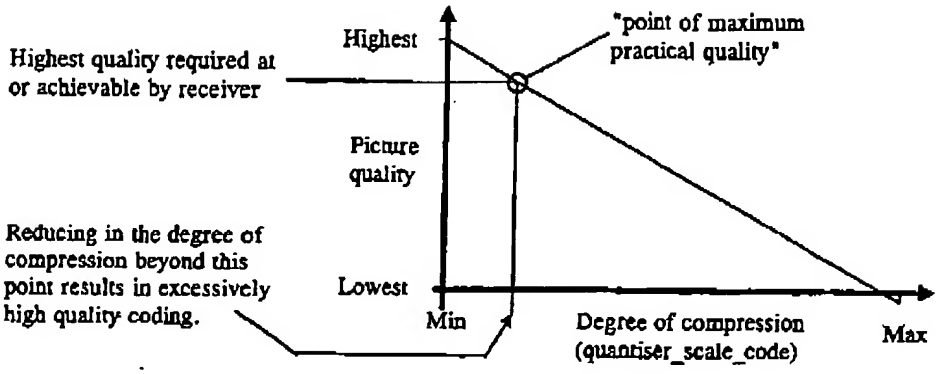

Figure 1

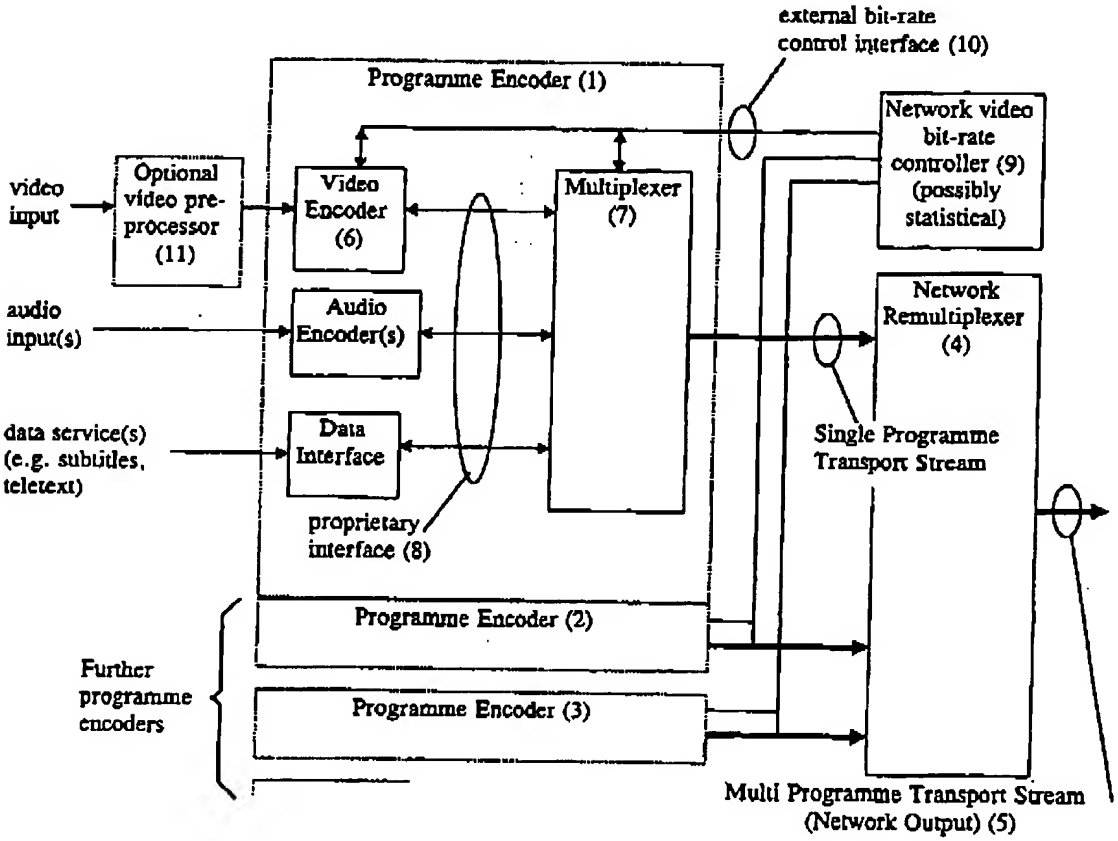

Figure 2

IMAGE ENCODING

This invention relates to image encoding and is concerned in the most important example with video encoding in digital television services.

The international standard ISO/IEC13818 (generic coding of moving pictures and associated audio information), known commonly as MPEG2, has been widely adopted as the method of encoding media and binding them together in a multiplex for transmission as digital services.

In this system, media are compressed by removing temporally and spatially redundant information. Psycho-visual and psycho-acoustic models are also employed to reduce the information content of the compressed signal.

It is of course desirable to use the transmission bandwidth of any system to the greatest effect. For digital television services this entails a complex balance of factors such as the desired number of services, perceived picture quality, acceptable quality audio and adequate bandwidth of supporting and ancillary data.

The amount of information required to encode a video sequence according to the specification ISO/IEC13818 is highly dependent on the source material. It is generally the case that images with fast motion or high levels of detail require more bits of information to encode them to a comparable quality.

To accommodate the variable nature of this encoding process both the encoder and decoder contain a buffer into which the compressed image data is fed and subsequently removed and sent on to be included in a multiplex or decoded. Within the encoder a feedback process governs the degree of compression applied to the pictures of the sequence to ensure that neither encoder nor decoder buffer overflows through holding too much data or underflows. The encoder's buffer will underflow if the buffer manager attempts to draw more elementary data from it than is currently held, the decoder buffer underflows if a picture's due decoding time passes before all the information needed to decode it has arrived in

the buffer.

It is an object of one aspect of the present invention to provide an improved method of image encoding which enables more efficient use to be made of transmission bandwidth, or other bit constraint, on the encoded signal.

Accordingly, the present invention consists in one aspect in a method for compression coding of an image signal, the visual quality of a displayed image generated through decoding of the compression coded signal being in general terms inversely related to the degree of compression, wherein a determination is made of the maximum practical visual quality ascertainable in the displayed image and the degree of compression controlled such that the degree of compression is not reduced beyond a level which would produce a visual quality in excess of said maximum practical visual quality.

In another aspect, the present invention consists in a method for compression coding of an image signal to produce a bit rate reduced signal which can pass through a bandwidth limited channel to a downstream compression decoder generating a decoded image signal for display, compression encoding parameters being variable with variations in the image signal, characterised in that a determination is made of a point of maximum practical quality in the decoded image signal and the compression encoding parameters being controlled in response to said determination.

In one form of the invention, there is calculated a "a point of maximum practical quality" for a compressed image in order to prevent it from consuming more bandwidth then necessary during transmission. This invention exploits the fact that within a typical broadcast environment video encoders may frequently, subject to the encoded material, encode an image with a quality in excess of that needed to produce an acceptable image to the viewer. This comes about due to limitations on the part of the receiving equipment, the receiver's connection to the display and the viewing environment.

This invention therefore prevents wasted bandwidth and in one example recoups it to carry other information within the multiplex.

The invention will now be described by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a graph illustrating a feature of the present invention; and

Figure 2 is a block diagram illustrating an example of the use of the present invention.

The number of data bits generated as a result of encoding each picture of a video sequence according to the MPEG-2 video coding scheme is highly variable. Many factors contribute to this variation but it is generally true that sequences containing fine detail, fast motion and frequent shot changes will produce far more bits per picture than would the compression of less demanding material.

To accommodate this variation in coded data rate, a video encoder contains a buffer into which the data resulting from the compression of each picture is placed and is subsequently read at the rate (which may be constant) apportioned by a downstream multiplexer. A feedback process within the encoder aims to prevent this buffer from completely filling or emptying by varying the severity of compression applied in the picture coding process. A high degree of compression causes the encoder to generate fewer bits per picture. In practice, the degree of compression is increased by making the quantisation used in the video encoding process more coarse (i.e. increasing the value of the "quantiser_scale_code" parameter) and results in reduced coded picture quality.

When coding less demanding picture material, an encoder will generally need to reduce the amount of compression applied in the encoding process to ensure that sufficient bits per picture are generated to prevent the buffer from emptying completely. With very simple picture material, even reducing the degree of compression to the minimum possible may not generate a sufficient number of bits per picture. In this case, the encoder is forced to insert stuffing bits into the coded video

data which convey no information and serve only to prevent the buffer from emptying.

A video encoder operating at or near minimum compression will produce pictures of a high quality to the original material. The quality of the decoded image may frequently be higher than that needed to produce an acceptable result at the receiver and display device. The image quality may even be beyond what the receiving equipment may be capable of displaying or the viewer perceiving.

Therefore there exists a minimum practical degree of compression that may be applied to the image below which there is no additional improvement to the perceived quality of the image. Henceforth this point is referred to as the "point of maximum practical quality". This concept is illustrated by Figure 1.

As an example of use for this invention take a transmission system of one or more encoders creating a multiplex. When any of the encoders finds it is able to produce an image above the level of highest quality it will in accordance with the present invention constrain itself to producing an image at the "point of maximum practical quality". This can be achieved by increasing (or failing to reduce) the degree of compression and reducing the elementary stream bit rate out of the encoder. Typically, a coarser quantisation process will be employed than (in the absence of the present invention) would otherwise have been chosen, preferably through increasing the value of the "quantiser_scale_code" parameter. By doing so it produces no more information for transmission than is practical, leaving that bandwidth available for other uses.

In Figure 2, there is shown in block diagram form an example of a transmission system in which the present invention is useful, the outputs of a number of separate programme encoders (1), (2) & (3) are combined in network remultiplexer (4) to create the multi-programme transport stream (5) which is the network output multiplex. Each programme encoder contains a video encoder (6) which encodes input video according to a video coding standard (e.g. MPEG-2). The multiplexer (7)

requests data from the video encoder in order to fill the payloads of transport packets. Requests for video data and delivery of returned data takes place via proprietary interface (8). The number of transport packets filled with video data per unit time is set by the network video bit-rate controller (9) communicating with the video encoder and multiplexer via external bit-rate control interface (10). The network video bit-rate controller may assign fixed bit-rates to each video encoder or it may vary the assignments dynamically in order to create a statistical multiplex. The video encoder is configured in accordance with the present invention such that it may not reduce the degree of compression applied below that associated with the point of maximum practical quality. This means that for some combinations of (simple) picture material and output bit-rates, the encoder will be unable to reduce the degree of compression to the level required to prevent the buffer from emptying completely. When the buffer occupancy reduces to a pre-determined minimum value, the video encoder ignores further requests for data from the multiplexer. In the absence of any returned video data, the multiplexer outputs a null packet in place of the intended transport packet which would otherwise have contained the returned video data. Because the video encoder is no longer sending data to the multiplexer, yet data resulting from the coding of new video source material is still entering the buffer, the buffer occupancy will increase. When the buffer occupancy has risen above the pre-determined minimum value, the encoder will respond normally to requests for data from the multiplexer. Thus the objectives of this invention are fulfilled: Video encoders are prevented from encoding to a quality in excess of the point of maximum practical quality and the multiplex capacity that would otherwise be wasted carrying the excessively high quality video is translated into a maximum number of null packets available for downstream opportunistic data insertion.

It must be recognised that this is only one way in which advantage can be taken of the bit capacity released by an encoder in which the degree of compression is not reduced beyond a level associated with maximum practical visual quality in the decoded image.

CLAIMS

1. A method for compression coding of an image signal, the visual quality of a displayed image generated through decoding of the compression coded signal being in general terms inversely related to the degree of compression, wherein a determination is made of the maximum practical visual quality ascertainable in the displayed image and the degree of compression controlled such that the degree of compression is not reduced beyond a level which would produce a visual quality in excess of said maximum practical visual quality.

2. A method for compression coding of an image signal to produce a bit rate reduced signal which can pass through a bandwidth limited channel to a downstream compression decoder generating a decoded image signal for display, compression encoding parameters being variable with variations in the image signal, characterised in that a determination is made of a point of maximum practical quality in the decoded image signal and the compression encoding parameters being controlled in response to said determination.

3. In a system of one or more encoding and packet multiplexing entities, at least one encoding entity practising the method of Claim 1 or Claim 2, to allow transmission bandwidth that would otherwise have been used to carry unneeded image information to be used to enhance other images of the service and or multiplex.

4. A system according to Claim 3, wherein transmission bandwidth that would otherwise have been used to carry unneeded image information is used to include other streams of media, data or information in the service and or multiplex.

Patent Office

7.

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Claims searched: 1-4

Examiner: John Coules
Date of search: 22 December 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4F FRM,FRX,FRW

Int Cl (Ed.6): H04N 7/26,7/30,7/32,7/50

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2306840 A	(University of Strathclyde) see whole doc	2 at least
X	GB 2261567 A	(Televerket) see whole doc	2 at least
X	GB 2257595 A	(Matsushita) see whole doc	2 at least
X	EP 0721174 A2	(Eastman Kodak) see whole doc	2 at least
X	WO 97/39584 A1	(Imedia) see whole doc	2 at least
X	US 5710595	(Lucent) see whole doc	2 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.